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Exploiting Readily Available Information to Support Everyday Creativity on the Move

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Abstract. The advent of smartphones has enormously expanded utilitarian capabilities of mobile computing and has provided many advanced capabilities to their users. We take advantage of the advanced interaction capabilities of smartphones to enable their user perform exploratory search with the goal of fostering inspiration. Our search application combines diversification of content and sources with a user interface design that utilises cues from the social chatter to perform query expansion and let users interactively explore the available information space.

Keywords: Exploratory search; inspirational systems

1 Introduction

Mobile phones are starting to dominate as the primary mode of accessing the Internet while on-the-move [9]. We focus on how to foster user inspiration when using their mobile phones to search for information. Our work is motivated by the observation that social recommendations through e.g., social media feeds, already provide an everyday inspirational channel to people. Many users already use social media such as Twitter for exchanging links to web pages that are of interest to them. Such links, although not necessarily relevant to an explicitly expressed need, have the potential to inspire. In this paper, we aim to examine how to extract inspirational clues from social chatter and other Web sources, and use them to assist users in finding inspirational information when on the move.

Social chatter may contain valuable information that can inspire, though it is difficult for the user to process each nugget of information manually. Moreover, the inspiration potential of each informational resource may increase if combined with other clues and used to enhance a targeted search initiated by the user. For example, [3] showed that focusing search on the referrals of the users' friends can return highly serendipitous results, albeit with lower relevance to the query. Further, time and attention are scarce resources for users on the move. Hence, there is a need for a new

search approach that will leverage social and web content with the aim to inspire smartphone users.

We follow the approach of funnelling social chatter into an information seeking service that enables users to indirectly consume streams of information, not by reading them explicitly, but by utilizing information embedded in them in order to expand their search queries. To assess if our approach helps users become inspired, we implemented m-CRUISE, a mobile application that uses Creative User Centric Inspirational Search (CRUISE) [17], a service that helps users to explore inspirational cues through various sources of information. M-CRUISE enables users to utilise clues from the social chatter and the Web at large in order to expand their queries. M-CRUISE lets the user initiate a query and then, using available sources of information, choose the path through which she can enrich and broaden the query. In this way the user proceeds in an exploratory search session through which she is able to formulate and re-formulate the original query by taking advantage of the social chatter and other Web resources.

2 Fostering Inspiration with Search Support

Creativity is the process of generating new ideas and concepts or making connections between ideas into producing new ones, which previously did not exist [2]. Among the most important enablers of creativity is the capability to be inspired. Inspiration requires among others an environment that offers space for exploration, cognitive stimuli and accessibility to information resources [21]. The explosion of the World Wide Web has made the amount of available information tremendous, which, thanks to ubiquitous technology adoption, widespread use of mobile devices, broadband Internet penetration and increasing computing power, can be consumed anywhere, anytime and on any device. Moreover, the Web 2.0 phenomenon has created a paradigm shift in which users not only consume but also generate content through various Web apps and social media. Web 2.0 technology allows users to create, collaborate, share and publish content, enabling information sharing and the rapid dissemination of new ideas e.g. social networking sites, wikis and blogs. This activity of user generated content creation in systems for social creativity, such as Flickr and Wikipedia is called ‘produsage’ [7] and highlights a shift in the balance from consumer to producer and to cultures of participation [11].

The abundance of easily accessible information has boosted the development of novel information retrieval approaches and applications for making sense of available information. There is a great potential for applying novel computational algorithms and smart user interfaces in order to tap into available content and discover, shape and render inspirational resources in ways that can help users be creative in their everyday activities. The concept of everyday creativity was defined, assessed, and validated in 1988 by Ruth Richards, Dennis Kinney, and colleagues at Harvard Medical School [16]. They defined it as expressions of originality and meaningfulness in everyday, real-life situations and distinguished it from creativity in arts, sciences and other special fields of endeavour in which special capabilities and talent are essential prerequi-

sites. Our work focuses on exploiting advances in exploratory search and information retrieval computational algorithms in order to support users be inspired from publicly available information so that they can creatively address everyday tasks using their mobile devices. We argue that serendipitous encounters with inspiring information resources in everyday creative activities can leverage learning according to the discovery learning theory.

Discovery learning is an inquiry-based, constructivist learning theory that takes place in problem solving situations where learners draw on their own past experience and existing knowledge to discover and learn new facts and relationships [6]. Learners interact with the world by exploring and manipulating objects increasing the likelihood to remember concepts and knowledge discovered on their own. Models that are based on discovery learning include guided discovery, problem-based learning, case-based learning, and incidental learning. Computational tools for inspiration can be a lever for discovery learning because they encourage active engagement, promote self-motivation, give autonomy to users in dealing creatively with situations and facilitate the development of creative problem solving skills.

3 Related Work

We distinguish two areas which are related to our work: interactive exploration of information and understanding information needs of mobile users.

Contrary to typical information retrieval systems that direct users to specific information resources, interactive information exploration systems are designed to reveal latent, alternative directions in the information space in order to enable user orientation and engagement [4], [18]. To this end, researchers have proposed a variety of techniques involving rich user interface support with learning algorithms to assist users to comprehend the results and the existing information space [3], and visualizing and summarizing the resulting information to enable faster relevance judgment of the quality of the information returned by the search engine [13]. Głowacka et al. [12] developed an interactive information retrieval system that combines Reinforcement Learning techniques along with a user interface design that allows active engagement of users in directing the search. Devendorf et al. [10] proposed a novel interactive interface for guided exploration through topics visualization over a large corpus. TweetMotif [15] extracts a set of topics from Twitter in order to provide a faceted search interface. Finally, several works have focused on the exploration of image and other rich media resources, see e.g. [19].

Understanding the needs of the user who enters a search activity is key for providing useful results. Mobile applications typically use some kind of contextual information (e.g. location) to filter and customize results [15]. Most applications utilise location information or examine user preferences from previous searches to generate information which they will use to guide a future search [20,14]. This feature is particularly used in targeted search applications, e.g., for entertainment & leisure, in which user preferences are persistent. Such approaches are not applicable in our case

because we aim to understand the user needs from the interactional context of the current session.

4 Mobile Creative User Centric Inspirational Search

We developed m-CRUISE with the main objective to support search for inspirational resources while on the move. The app couples techniques inspired from social search with information visualization and diversification. In this section we briefly describe how the two main features of the app interface design.

Extracting and visualizing cues: m-CRUISE utilises information from various social media and search engines to support users explore available search spaces. The exploration starts with the users entering a set of terms as an initial entry point to their exploration. The app uses the exploration terms and queries Twitter, Bing and Flick-r for the most recent and relevant resources. Then it constructs a list of resources which the user can scroll to explore the whole result set. The order of the results in the resultset list is differentiated from the order that the search APIs of the commercial search engines return by applying a diversification algorithm, which is known as MMR (Maximal Marginal Relevance) [8]. MMR framework re-ranks the results with a goal to reveal content that is related to all the possible aspects of the query in the top positions. We considered about diversifying the results based on the assumptions mentioned in [1] that the typical user checks the top ten to fifteen search results before proceeding to the reformulation of her query and that by providing a broader set of aspects could enhance the user's capability to diverge.

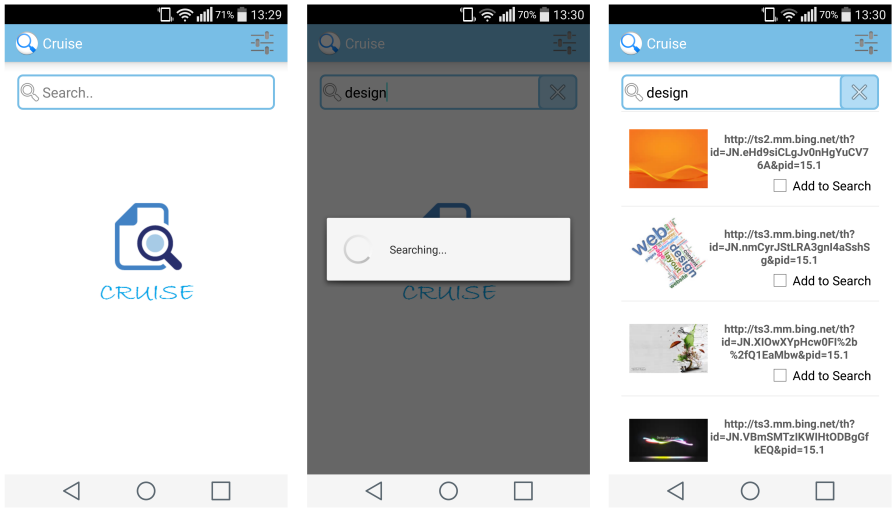

Fig.1. The result list can be used for query expansion.

Exploring the information space: The user can browse the available information space through the list, read the details of each resource and make multiple selections in order to improve the results of the next search. This interaction creates new conditions for exploration in the list. In this way the user gradually enriches the original query and creates paths for refined searches.

We present a simple search example using m-CRUISE. The user is interested in the design of a software engineering template. By opening the application, the user starts an exploration using as a search query the word “design”. The app creates a set of social media and web results which are related to the query design. The user browses through the result list and after noticing an interesting post, she can use it to refine her search. In our case the user chooses the word «Web» which is placed in the search field. The application, after the second search, displays the list of the new results (Figure 1).

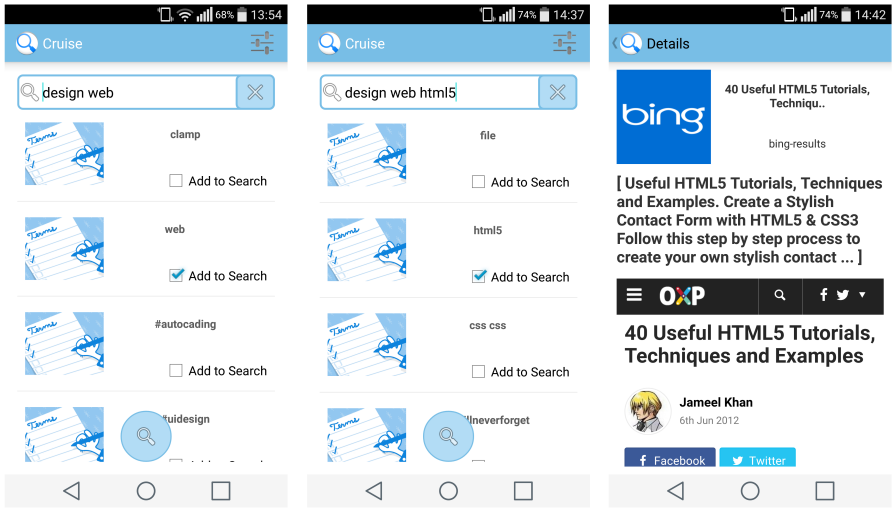

Fig.2. The user makes a focus-shift initiating an exploration with new terms.

Next, the user continuous to explore the new result set and spots «html5», which she adds to her query. The app returns a list of new results. The new results include a website titled «40 useful html 5 tutorials» which contains useful tutorials with tips and suggestions for creating templates with Html 5 (Figure 2). The user chooses to store this resource while she may also want to use it to amend her query and continue her quest for more information resources.

5 App Design& Implementation

M-CRUISE comprises two sub-systems. The first sub-system concerns the service (data and information) provided by the application to the user and the second sub-system provides the user interface of the service.

Backend Service Sub-system

The service sub-system has been developed according to the architecture shown in Figure 7. The core of the sub-system is the 'Services' component, which exposes two main functionalities. The first functionality provides a ranked set of terms extracted from social networks streams and sorted by their term frequencies. The second functionality provides diversified results stemming from queries on information sources, like public search engines, image services, or intranet repositories.

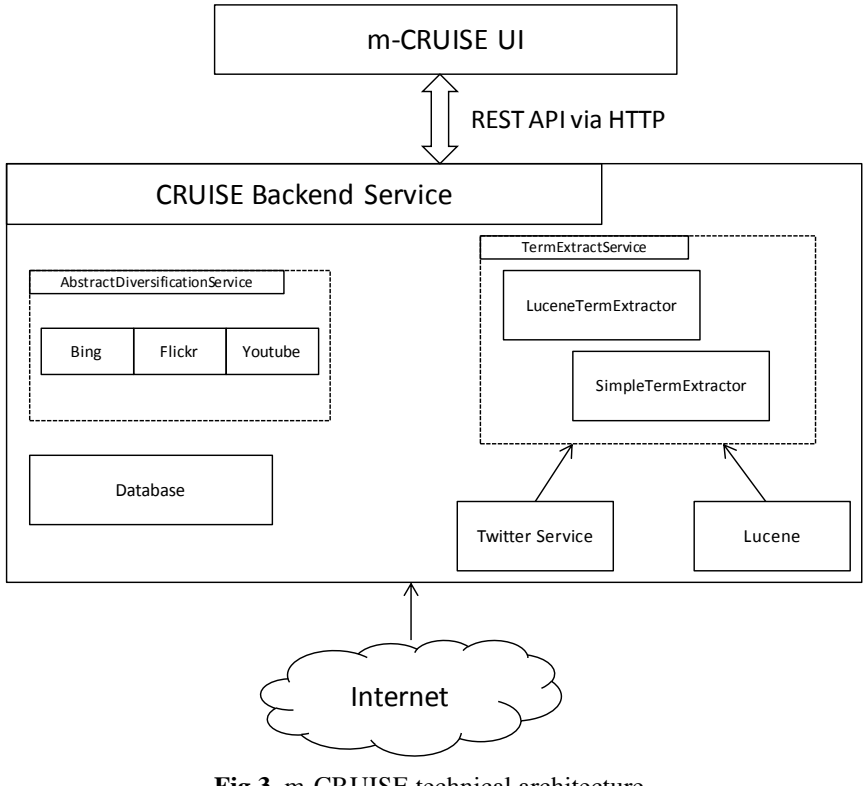

Fig.3. m-CRUISE technical architecture.

Information from social network streams is handled by implementations of the TermExtractService interface. TermExtractServices should satisfy a set of API calls

and return a weighted list of terms based on their frequencies. The current version of the system focuses on information gathered from the Twitter stream, which is accessed via the Twitter Search API. Furthermore, there are two available implementations of the TermExtractService: the LuceneTermExtractor and the SimpleTermExtractor.

The LuceneTermExtractor computes the weighting of the terms in the tweets provided by the Twitter Search API as described in the previous section and stores them in a Lucene Index[1]. It is also responsible for combining the terms in N-Grams. The SimpleTermExtractoris used when there are only a few results and TF/IDF is not the proper approach for determining the importance of a particular term. For example if the results returned by the Twitter API are less than 100 it would be best to use the SimpleTermExtractor, due to the small document corpus and text found within. The SimpleTermExtractoruses the term frequency provided by the Lucene index in order to assign weights to the terms without involving TF/IDF calculations.

Diversification of results from information sources is provided by implementations of the AbstractDiversificationService. At the time of writing we support four information sources, namely Bing, Flickr, YouTube and Twitter. Each implementation is responsible for fetching query results from the selected information sources (search results, images, papers, etc.), either by consuming available Application Programming Interfaces (APIs) or through automatic crawling of the available information (i.e. screen scraping).

The current version of the service sub-system is deployed in the Okeanos cloud services platform (https://okeanos.grnet.gr/) for the research community to ensure uptime and scalability, although it can be deployed in any networked server running a *nix flavour operating system[2].

The use of modular design patterns and principles along with the appropriate frameworks allows the system to be extended to include a plethora of social streams which inject the results into the implemented TermExtractServices. Furthermore, at the other end of the exploration flow we can add any number of information sources by extending the AbstractDiversificationService.

User Interface Sub-system

With regards to the second sub-system implementing the UI of the application, this has been developed with the following three design considerations in mind: (i) simplicity; (ii) facilitating access to the core of information; and (iii) easy navigation with minimal interaction for users on the move.

The UI sub-system has been developed and implemented using the eclipse integrated development environment using the ADT plug-in for developing android applications. ADT extends the capabilities of Eclipse to let developers quickly set up

[1]Apache Lucene is a free/open source information retrieval software library, see http://lucene.apache.org/core/ for more information.

[2]Please visit http://imu.ntua.gr/software/cruise for a url pointing to a working installation of CRUISE.

new Android projects, create an application UI, add packages based on the Android Framework API. The UI sub-systems has been developed with the Java Programming language. It supports android operating systems with version 3.0 (Api level 11, Honeycomb) and above, that is 93, 7% of available devices (according to the latest data). The UI can adapt to the size of the android device in order to enable easy navigation and rendering of information.

CRUISE as well as the CRUISE UI have been implemented using solely open standards compliant libraries, given that the implementation itself is open sourced under LGPL. Given the nature of the project we selected the Java Programming Language and the J2EE specification as the foundation for implementing and extending the system. Furthermore the use of the Spring Application Framework provided us with the ability to design a modularized system from the start, by adhering to the Inversion of Control design pattern.

6 Evaluation

We conducted a pilot study to evaluate in order to evaluate the specific research objectives of m-CRUISE and whether the application is subjectively better for leveraging inspiration than standard query-based interfaces. Thus, the baseline system was a typical query–based retrieval system, which used neither social chatter-based term extraction, nor search path exploration and resource diversification. The search spaces and underlying search engines were the same in both systems. In the baseline, users could express their information need only through typing queries and the results were presented as a list of resources.

We recruited 25 android users to participate in the evaluation study. The participants recruited for evaluating m-CRUISE were university students studying various subjects whose ages ranged from 18 to 25 years. We limited participants to this age group in order to ensure familiarity with mobile applications. Their task was to use m-CRUISE to come up with ideas on everyday tasks. We did not limit the time available to complete the task in order to let the users search and explore information for as long needed to come up with ideas relevant to the task at hand. Participants performed the task using m-CRUISE and using the baseline system.

Participants received a questionnaire with a set of questions aiming to evaluate both m-CRUISE and the baseline search engine. The questions given to the participants were pertinent to three key criteria for evaluating a creativity process: Participants were asked to evaluate the results for ***novelty*** (whether a given resource was showing a new aspect), ***value*** (whether this resource provides value to the use in her quest to come up with ideas) and ***unexpectedness*** (whether this resource was relevant to the assignment yet not directly related and not expected to be found, i.e. the so-called ‘surprise effect’). Table1 shows the evaluation results for m-CRUISE.

Table 1. Overview of the average and standard deviation for our post pilot study questionnaire based on a five-point Likert scale from 1 (No agreement) to 5 (Absolute agreement).

Cri.	Aspect	Mean	Std
Value	Your original query related directly to the results.	3.2	0.3
	Results were useful.	3.5	0.4
	Results helped you improve the formulation of your original query.	3.7	0.2
	Results helped you re-direct your original query.	3.6	0.5
	You spotted a solution among the results.	3	0.3
Novelty	The application helped you find new information.	3.3	0.5
	The application helped you find new search directions.	3.8	0.7
	You came up with new queries.	3.7	0.6
	Results revealed new information that was not associated with your original query.	3.2	0.2
Unexpectedness	You were surprised with how some results were connected with your original query.	3.8	0.3
	Results were surprising.	3.9	0.4

Although usability is not directly linked to creativity, it does become relevant when considering that m-CRUISE is a new software and that if the software is not usable it cannot support creativity. We approached usability assessment in a qualitative manner, asking participants to report any difficulties or challenges they faced when using m-CRUISE. Participants highlighted the importance of filtering the content retrieved by the software. For instance, "results included twitter names and words that had not meaningful relation to the query e.g. 70's or @xbox or 9h5w". Moreover, they mentioned that "it did not seem to provide any guidance that would help them understand its use". Furthermore, they stressed that "sometimes the processing took a while that might become a pitfall especially for new users". We proceeded with changes regarding the feedback. Specifically, we refined the display of results by further processing and filtering of the tweets in order to provide useful and meaningful content. Moreover, we made changes to the interface so as to guide the user to each step of the process, as well as refinements on the implementation of the back-end service to reduce the response time.

Table 2 shows a comparative view of the evaluation results obtained with m-CRUISE and the baseline system, using the same set of questions. Results are averaged across all questions of each criterion. We observe that m-CRUISE is more effec-

tive in inspiring the users than the baseline system, as assessed on the basis of the three creativity-related criteria (novelty, value and unexpectedness of results). The users responses indicate that m-CRUISE provided more unexpected results (m=3.85 against m=3.10) which helped them to expand the search space and re-direct their original query. Moreover, there is a noticeable difference, i.e., 0.4, between the two mean ratings of the two systems on the criterion of novelty. The group of questions to which participants answers differentiated the least between the two systems was the one corresponding to the criterion of value in which the difference between the mean ratings was 0.3.

Table 2. Overview of the ratings of results for m-CRUISE and baseline

Type of results	Mean per session
Novel	Cruise: 3.40 Baseline: 3.00
Valuable	Cruise: 3.50 Baseline: 3.20
Unexpected	Cruise: 3.85 Baseline: 3.10

In addition to the questionnaires results, we gathered participants' comments about the capability of both the mobile app and the underlying search service to leverage inspiration. The overall impression from the participants' comments was positive. Many of the participants commented the easy access that m-CRUISE provided in order to access social and Web resources without having to be redirected to a website and hence loose valuable time and without having to switch their attention to another application. Many participants commented that with CRUISE they could "reach inspiring information from search engines and social media faster". Another participant commented that "The way that m-CRUISE presents information helped me to redirect my original question". Moreover many participants commented that using m-CRUISE triggered new questions related to the original query. Another participant suggested that "Maybe m-CRUISE would be better if it had more than three search levels". Some participants suggested that the user should get feedback about the origin of the related tweet. The diversity of sources was appreciated because they "didn't always get common results in the top ranks". However, the use of just one social media source (Twitter) was considered very restricting in terms of the variety of viewpoints they could get.

7 Conclusions

We presented an interactive, exploratory mobile search application that combines diversity of content and information sources with a novel user interface design to allow Web content and the social chatter generated with micro-blogging services such as Twitter to actively help users in exploring information spaces. Users can direct their search by manipulating results extracted from online resources and formulate new search paths. The mobile version of CRUISE has been implemented using solely

open standards compliant libraries with the Java Programming Language and the J2EE specification. The application supports any type of android device (phones, tablets) with android platform version 3.0 (API level 11, Honeycomb) and above. The current version of the application takes advantage of the CRUISE back end search service, deployed in the Okeanos cloud services platform (https://okeanos.grnet.gr/). The use of modular design patterns and principles along with the appropriate frameworks allows the system to be extended in order to include additional social streams. The application can be easily extended in order to be able to tap onto additional information sources.

Our study provides some evidence that extracting inspirational clues from social chatter and other Web sources and using them in an exploratory search application can help users find inspirational information when on the move. According to the discovery learning theory, supporting people to deal autonomously and creatively with everyday problem solving tasks facilitates learning. We plan to perform further studies in order to verify this assertion and to investigate the scope of the activities in which m-CRUISE can indeed help its users become inspired and learn from their experience of dealing creatively with everyday activities. Moreover, we are experimenting with additional user interface designs that can help towards further improving the user experience, improving application performance and minimising the user attention disruption when using the application.

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References

1. Agrawal, R., Gollapudi, S., Halverson, A., &Ieong, S. Diversifying search results. In Proc. WSDM 2009, ACM Press (2009), 5-14.
2. Amabile, T.M.: Creativity and innovation in organizations, Harvard Business School (1996), 1–15.
3. Baldonado, M., and Winograd, T. Sensemaker: an information-exploration interface supporting the contextual evolution of a user's interests. In Proc. SIGCHI 1997, 11–18.
4. Bernstein, M. S., Suh, B., Hong, L., Chen, J., Kairam, S., & Chi, E. H. Eddi: interactive topic-based browsing of social status streams. In Proc. UIST 2010, ACM Press (2010), 303-312.
5. Bouidghaghen, O., Tamine, L., Boughanem, M. Personalizing Mobile Web Search for Location Sensitive Queries. Mobile Data Management (MDM), 2011 12th IEEE International Conference on 6-9 June 2011, pages 110-118.
6. Bruner, J.S. On knowing: Essays for the left hand. Cambridge, Mass: Harvard University Press, 1967.
7. Bruns, A. Produsage: Towards a Broader Framework for User-Led Content Creation. Creativity and Cognition: Proceedings of the 6th ACM SIGCHI conference on Creativity & cognition, ACM Press (2007), Washington, DC.: 99-106.

8. Carbonell, J., & Goldstein, J. The use of MMR, diversity-based reranking for reordering documents and producing summaries. In Proc. SIGIR 1998, ACM Press (1998), 335-336.
9. Church, K., Oliver, N. Understanding Mobile Web and Mobile Search Use in To-day's Dynamic Mobile Landscape. MobileHCI '11 Proceedings of the 13th International Conference on Human Computer Interaction with Mobile Devices and Services, 67-76.
10. Devendorf, L., O'Donovan, J., & Hollerer, T. TopicLens: An Interactive Recommender System based on Topical and Social Connections. In Proc. RecSys 2012, 41.
11. Fischer, G. & Shipman, F. "Collaborative Design Rationale and Social Creativity in Cultures of Participation," Human Technology: An Interdisciplinary Journal on Humans in ICT Environments (Special Issue on Creativity and Rationale in Software Design), 7(2), 2011, 164–187.
12. Glowacka, D., Ruotsalo, T., Konuyshkova, K., Kaski, S., & Jacucci, G. Directing exploratory search: Reinforcement learning from user interactions with keywords. In Proc. IUI 2013, ACM Press (2013), 117-128.
13. Havre, S., Hetzler, E., Perrine, K., Jurrus, E., and Miller, N. Interactive visualization of multiple query results. In Proc. IEEE Symposium on Information Visualization 2001, 105.
14. Neumann, G. & Schmeier, S. Strategies for Guided Exploratory Search on the Mobile Web. Knowledge Discovery, Knowledge Engineering and Knowledge Management, Communications in Computer and Information Science Volume 415, 2013, 53-67.
15. O'Connor, B., Krieger, M., & Ahn, D. TweetMotif: Exploratory Search and Topic Summarization for Twitter. In Proc. ICWSM 2010.
16. Richards, R. Everyday Creativity and New Views of Human Nature: Psychological, Social, and Spiritual Perspectives, 2007, APA press.
17. Taramigkou, M., Paraskevopoulos, F., Bothos, E., Apostolou, D. and Mentzas, G. (2014) Leveraging User Inspiration with Microblogging-Driven Exploratory Search, L. Iliadis, M. Papazoglou, and K. Pohl (Eds.): CAiSE 2014 Workshops, LNBIP 178, 238–249.
18. Teevan, J., Alvarado, C., Ackerman, M.S., Karger, D.R.: The perfect search engine is not enough: A study of orienteering behavior in directed search. In: Proc. of SIGCHI 2004, 415–422.
19. Waitelonis, J., & Sack, H. Towards exploratory video search using linked data. Multimedia Tools and Applications 59, 2 (2012), 645-672.
20. Westlund, O., Gomez-Barroso, J-L., Compano, R. and Feijoo, C. Exploring the logic of mobile search. Behav. Inf. Technol. 30, 5 (September 2011), 691-703.
21. Woodman, R.W., Sawyer, J.E., Griffin, R.W.: Toward a theory of organizational creativity. Academy of Management Review, (1993), 293–321.